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NASA CR-
160204

HOUSTON, TEXAS

TECHNICAL INFORMATION RELEASE

TIR 741-MED-3006

FROM R. C. Croston, Ph.D.	TO J. A. Rummel, Ph.D.		
DATE 1/11/73	WORK ORDER REF: DM-110T	WORK STATEMENT PARA: NAS9-12932	REFERENCE:
SUBJECT User's Instructions for the Cardiovascular Walters Model			

(NASA-CR-160204) USER'S INSTRUCTIONS FOR
THE CARDIOVASCULAR WALTERS MODEL (General
Electric Co.) 15 p HC A02/MF A01 CSCL 06B

N79-25721

Unclassified
G3/52 22193

This model is a combined, steady-state cardiovascular and thermal model. It was originally developed for interactive use by Dr. R. F. Walters, Department of Human Physiology, School of Medicine, University of California, Davis, California. The model has been converted to batch mode simulation for the Sigma 3 computer. The purpose of the model is to compute steady-state circulatory and thermal variables in response to exercise work loads and environmental factors. During a computer simulation run, several selected variables are printed at each time step. End conditions are also printed at the completion of the run.

R. C. Croston, Ph.D.

Attachment
/db

CONCURRENCES

Counterpart:

DISTRIBUTION GE/AGS: Central Product File
R. F. Hassell
V. J. MarksMedical Projects Engr'g & Advanced Programs
Unit Manager: CWG Fulcher Subsection Mgr.: WJBittelNASA/JSC:
Tech. Library/JM6 (1979 distribution)Page No.
1 of 1

PROGRAM DESCRIPTION

A. IDENTIFICATION

Program Name - WALTERS
Programmer - R. C. Croston, GE/MSC, Houston
Date of Issue - April 6, 1972

B. GENERAL DESCRIPTION

This model is a combined, steady-state cardiovascular and thermal model. It was originally developed for interactive use by Dr. R. F. Walters, Department of Human Physiology, School of Medicine, University of California, Davis, California. The model has been converted to batch mode simulation for the Sigma 3 computer.

C. USAGE AND RESTRICTIONS

Machine and Compiler Required - XDS Sigma 3 and ANSI FORTRAN
Peripheral Equipment Required - Card reader and line printer.
Approximate amount of memory required - 2,465 hexadecimal

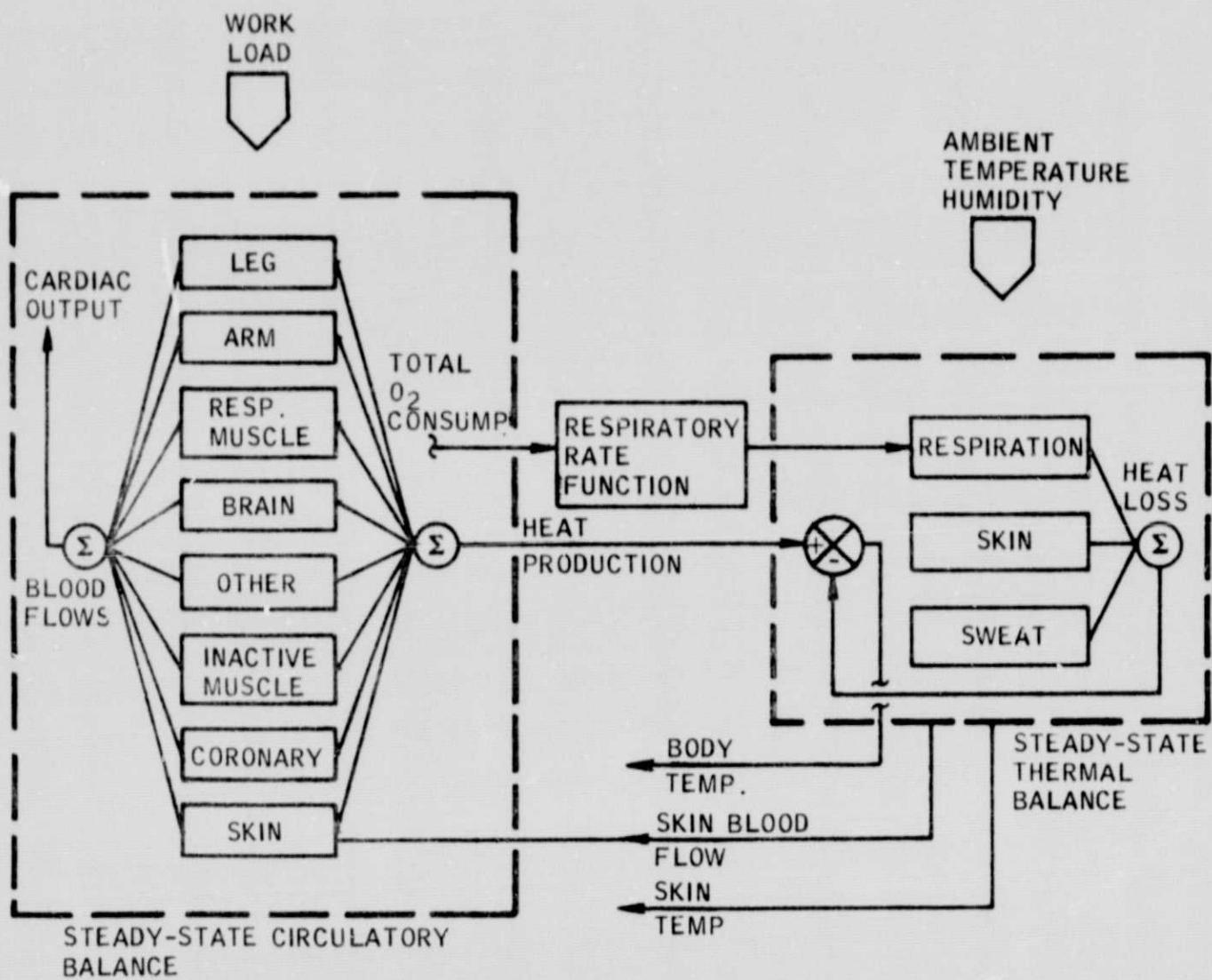
D. PARTICULAR DESCRIPTION

Equations Used and Derivations - See final report of Contract NAS9-11657, Modification 2C.
Definition of Terms Used - Terms are defined in the referenced math model and in the following descriptions of input and output variables.
Detailed Description - The mathematical model is summarized here by a functional block diagram, Figure 1. The purpose of the model is to compute steady-state circulatory and thermal variables in response to exercise work loads and environmental factors. During a computer simulation run, several selected variables are printed at each time step. End conditions are also printed at the completion of the run.

E. DESCRIPTION OF INPUT

Control and Program Cards - (begin in card column 1)

```
:J0B
!ASSIGN SI=14      (026 Keypunch Code)
!ASSIGN F:5=3
!ASSIGN F:6=4
:F0RTRAN
```



COMBINED STEADY-STATE
CIRCULATORY AND THERMAL MODELS

FIGURE 1.

WALTERS MODEL FUNCTIONAL BLOCK DIAGRAM

(SOURCE DECK)

```
!EOD
!LQAD
!$R00T 256,,G0
!$MP
!EOD
!XEQ
```

(DATA DECK)

```
!EOD
```

Program Cards - Listed at the end of this document.

Data Cards - (Card columns, format, name definitions)

Columns 1-10, 11-20, etc., 8 parameters per card for a 8F10.0 format of the following list of required input data:

AVCOR	0.138	RESTING A-V DIFF, CORONARY
AVBR	0.069	RESTING A-V DIFF, BRAIN
AVMR	0.067	RESTING A-V DIFF, MUSCLE
AVSKIN	0.010	RESTING A-V DIFF, SKIN
AVOTHR	0.035	RESTING A-V DIFF, "OTHER"
AVRSPR	0.040	RESTING A-V DIFF, RESPIRATORY MUSCLES
AVMMX	0.165	MAXIMUM A-V DIFF, MUSCLE
AVRSMX	0.060	MAXIMUM A-V DIFF, RESPIRATORY MUSCLE
EFARMX	0.80	MAXIMUM EFFICIENCY, ARM MUSCLE
EFLGMX	0.80	MAXIMUM EFFICIENCY, LEG MUSCLE
PCTWLG	0.25	WEIGHT PERCENT, LEG MUSCLE
PCTWAR	0.15	WEIGHT PERCENT, ARM MUSCLE
PCTARS	0.05	WEIGHT PERCENT, RESPIRATORY MUSCLE
PCTWCU	0.015	WEIGHT PERCENT, CORONARY MUSCLE
PCTWIM	0.035	WEIGHT PERCENT, INACTIVE MUSCLE
STOPTM	71.0	STOP TIME FOR LENGTH OF EXPERIMENT (min)
TINC	10.0	TIME AT WHICH VARIABLES ARE INCREMENTED (min) (fixed)

MXRSP	0.315	SLOPE FACTOR FOR INCREASE IN RESP MUSCLE O ₂
TS	1.0	TIME STEP FOR MODEL (in minutes) (fixed)
VLPIKE	0.04	PERCENT OXYGEN UPTAKE IN VENTILATION
TAIR	20.0	AIR TEMPERATURE (°C)
RHUM	0.50	RELATIVE HUMIDITY
PATM	760.0	ATMOSPHERIC PRESSURE (mm Hg)
PO ₂	160.0	PARTIAL PRESSURE OXYGEN (mm Hg)
VAIR	0.1524	WIND SPEED (m/sec)
CORST	5000.0	RESTING CARDIAC OUTPUT (ml/min)
WGT	75.0	BODY WEIGHT (Kg)
HGT	175.0	HEIGHT (cm)
TB	36.8	BODY TEMP, INITIAL (°C)
HRRST	60.0	RESTING HEART RATE (beats/min)
HRMAX	200.0	MAXIMUM HEART RATE
VMAX	20000.0	MAXIMUM VENTILATION (ml/min)
TBMAX	41.0	MAXIMUM BODY TEMPERATURE (°C)
TPRNT	1.0	PRINT INTERVAL (min)
Col. 1-10, 21-30, 41-50, 61-70	8F10.0	Time to change work rate (sec)
11-20, 31-40, 51-60, 71-80	8F10.0	Work rate in KPM/min

(Seven of the above cards are required for a complete schedule.)

Time (seconds), oxygen uptake (ml/min), ventilation (ml/min), heart rate (beats/min), cardiac output (ml/min), body temperature (°C), and skin temperature (°C).

F. DESCRIPTION OF OUTPUT

The following variables are printed on the line printer. A sample printout is shown in Figure 2.

!JDB EY

!ASSIGN F:5=3

!ASSIGN F:6=4

WALTERS		V02	V	HR	C0	TB	TSK
0.0	246•6	6166•2	60.0	5000•0	36•8	32•7	12
1•0	246•6	6166•2	59•3	4945•7	36•7	32•7	
2•0	246•6	6166•2	59•3	4945•7	36•7	32•7	
3•0	246•6	6166•2	59•3	4945•7	36•6	32•7	
4•0	885•6	22141•2	106•6	8886•2	36•6	32•7	
5•0	916•1	22902•6	112•8	9398•0	36•6	32•7	
6•0	920•1	23002•9	113•6	9465•4	36•6	32•7	
7•0	920•6	23016•1	113•7	9474•3	36•5	32•7	
8•0	920•7	23017•8	113•7	9475•4	36•5	32•7	
9•0	281•7	7043•1	66•4	5535•1	36•5	32•7	
10•0	250•8	6271•1	60•2	5016•2	36•4	32•7	
11•0	246•8	5169•4	59•4	4947•9	36•4	32•7	
12•0	246•6	6166•2	59•3	4945•7	36•3	32•7	
13•0	246•6	6166•2	59•3	4945•7	36•3	32•7	
14•0	246•6	6166•2	59•3	4945•7	36•2	32•7	
15•0	246•6	6166•2	59•3	4945•7	36•1	32•7	
16•0	246•6	6166•2	59•3	4945•7	36•1	32•7	
17•0	1524•6	38116•1	153•9	12826•7	36•1	32•7	
18•0	1586•0	39649•6	166•3	13857•4	36•1	32•7	
19•0	1594•1	39851•6	167•9	13993•2	36•1	32•7	
20•0	1595•1	39878•2	168•1	14011•1	36•1	32•7	
21•0	1595•3	39881•7	168•2	14013•4	36•2	32•7	
22•0	317•3	7932•2	73•6	6132•8	36•1	32•7	
23•0	255•5	6388•2	61•1	5094•9	36•1	32•7	
24•0	247•4	6184•8	59•5	4958•2	36•0	32•7	
25•0	246•6	6166•2	59•3	4945•7	35•9	32•7	
26•0	246•6	6166•2	59•3	4945•7	35•9	32•7	
27•0	246•6	6166•2	59•3	4945•7	35•8	32•7	
28•0	246•6	6166•2	59•3	4945•7	35•8	32•7	
29•0	246•6	6166•2	59•3	4945•7	35•7	32•7	
30•0	246•6	6166•2	59•3	4945•7	35•7	32•7	
31•0	246•6	6166•2	59•3	4945•7	35•6	32•7	
32•0	2163•6	54091•1	188•7	15722•2	35•7	32•7	
33•0	2247•7	56191•9	196•1	16345•4	35•7	32•7	
34•0	2252•6	56314•0	196•2	16346•2	35•8	32•7	
35•0	2252•6	56314•2	196•2	16346•2	35•8	32•7	
36•0	2252•6	56314•2	196•2	16346•2	35•9	32•7	
37•0	335•6	8389•3	66•8	5569•7	35•8	32•7	
38•0	251•1	6277•8	60•2	5020•8	35•8	32•7	
39•0	246•8	6170•3	59•4	4948•5	35•7	32•7	
40•0	246•6	6166•2	59•3	4945•7	35•7	32•7	
41•0	246•6	6166•2	59•3	4945•7	35•6	32•7	
42•0	246•6	6166•2	59•3	4945•7	35•6	32•7	
43•0	246•6	6166•2	59•3	4945•7	35•5	32•7	
44•0	246•6	6166•2	59•3	4945•7	35•4	32•7	
45•0	246•6	6166•2	59•3	4945•7	35•4	32•7	
46•0	246•6	6166•2	59•3	4945•7	35•3	32•7	
47•0	246•6	6166•2	59•3	4945•7	35•3	32•7	
48•0	246•6	6166•2	59•3	4945•7	35•2	32•7	
49•0	2483•1	62078•6	189•3	1575•5	35•3	32•7	
50•0	2567•6	64189•8	196•8	16398•7	35•4	32•7	5

PRINTED IN U.S.A.

FIGURE 2.

WALTERS MODEL SAMPLE PRINTOUT

3 4
5 4
5 5
6 5
6 6
7 6
8 7
9 8
10 9
11 10
12 11

51.0	2572.5	64311.9	196.8	16399.5	35.4	32.7
52.0	336.0	8399.7	66.8	5569.5	35.4	32.7
53.0	251.1	6277.9	60.2	5020.8	35.3	32.7
54.0	246.8	6170.3	59.4	4948.5	35.3	32.7
55.0	246.6	6166.2	59.3	4945.7	35.2	32.7
56.0	246.6	6166.2	59.3	4945.7	35.2	32.7
57.0	246.6	6166.2	59.3	4945.7	35.1	32.7
58.0	246.6	6166.2	59.3	4945.7	35.1	32.7
59.0	246.6	6166.2	59.3	4945.7	35.0	32.7
60.0	246.6	6166.2	59.3	4945.7	35.0	32.7
61.0	240.6	6166.2	59.3	4945.7	34.9	32.7
62.0	246.6	6166.2	59.3	4945.7	34.8	32.7
63.0	246.6	6166.2	59.3	4945.7	34.8	32.7
64.0	246.6	6166.2	59.3	4945.7	34.7	32.7
65.0	246.6	6166.2	59.3	4945.7	34.7	32.7
66.0	246.6	6166.2	59.3	4945.7	34.6	32.7
67.0	246.6	6166.2	59.3	4945.7	34.6	32.7
68.0	246.6	6166.2	59.3	4945.7	34.5	32.7
69.0	246.6	6166.2	59.3	4945.7	34.5	32.7
70.0	246.6	6166.2	59.3	4945.7	34.4	32.7

SUMMARY OF CONDITIONS AT TIME OF STOP *

71. MIN

ENVIRONMENT

TAIR = 23.4

HUMIDITY = 0.5 PCT
ATM PRESS = 760.0
AIR SPEED = 0.2
LEG WORK = 33.5ML 02/MIN
ARM WORK = 13.4

* * BODY STATUS
BODY TEMP = 34.354
SKIN TEMP = 32.7
VENTILATION = 6166.2
O2 UPTAKE = 246.6
CARDIAC OUTPUT = 4945.7
HEART RATE = 59.3

* * OXYGEN DEBTS
CORONARY = 0.4
LEG = 11.5
ARM = 0.0
LEG RATE = 2.386 ML O2/MIN
ARM RATE = 0.0

G. INTERNAL CHECKS AND EXITS

Exit - A normal exit gives end conditions and a stop.

H. INDEPENDENT SUBROUTINES

None

I. SYSTEM SUBROUTINES

No special subroutines.

J. COMPLETION OR FINAL CHECKOUT DATE

April 6, 1972.

K. PROGRAM LISTING

AB*WGT**0.425*HGT**0.725 * * 00718
MLEG=PCTHLG+HGT
MARM=PCTHAR+HGT
MRESP=PCTHRS+HGT
MCOR=PCTHCOR+AGT
MIN=PCTWIM+GT
SV=CRST/HRRST
02LGX=MLEG+93.5
02ARMX=MARM+93.5
02CARMX=MCOR+93.5
DBLGX=MLEG+44/+0048
DBARMX=MARM+44/+0048
DBCJMX=MCOR+44/+0048
DTLGX=MLEG+70/+0048
DTARMX=MARM+70/+0048
BFBR=18*CRST
BFLEGR=1*CRST
BFARMR=0*CRST
BFCRR=04*CRST
BFSKNR=05*CRST
BFOTHR=53*CRST
B23RR=BFBR=AVBR
CD*CRST
02LEGR=BFLEGR+AVMR
02ARMR=BFARMR+AVMR
02CRR=BFCRR+AVCOR
02SKNR=BFSKNR+AVSKIN
02OTHR=BFOTHRAVOTHRA
02TTR=BF2BFR+02LEGR+02ARMR+02SKNR+02CRR+02OTHRA
PCTRSP=1.0 + 01*(760+PRESS)
IF (PCTRSP.GT.5.1 PCTRSP=5.
02RSRP=PCTRSP/100.*02TTR
02IMR=(6.*PCTRSP)/100.*02TTR
BFRSPR=02RSRP/AVRSPR
BFINR=02IMR/AVMR
BFLGMX=02LGX/16.*100.
BFARMX=02ARMX/16.*100.
BFCOMX=02COMX/13.*100.
MXCOR=(02COMX=02CRR)/(HRRMAX = 0.1*HRRMAX - HRRST)
HLSWMX=11.79*VAIR**37 +(HVSKN=RHUM+VABS)*ABSTS*.86/60.
IF (TAIR.LT.21.) TSKIN=32.75
IF (TAIR.LT.21.) TSKIN=32.75*0.25*(21.-TAIR)
BFSKNR=BFSKNR+11.-(32.75-TSKIN)*21)
400 IF (TSKIN.LT.32.75) GB TO 410
TBSW=36.9
GB TO 420
410 TBSW=(32.75-TSKIN)*16 + 36.9
420 02IM=02IMR*TS
HR=HRRST
02OTH=02OTHRA*TS
02BR=02BRR*TS
02LEGR=02LEGR
02LG=02LEG*TS
02ARM=02ARMR
02AR=02ARM*TS
02CRR=02CRR*TS
02RSP=02RSP*TS
02IM=02IMR*TS
02SK=02SKNR*TS

02TOT=02TATRAS
 WRITE (6,95) 02TOT,02LGR,02ZRR,02RSP,02COR,02SK,02IM,02OTH
 95 FORMAT (1,02TOT,BR,LEG,ARM,RSP,COR,SKIN,IM,OTH * /21H ,5F9.3/1)
 DBCB=0 116
 DBLEG=0 117
 DBARH=0 118
 DTDBAR=0 119
 DTDBLG=0 120
 V=02TOT/TS/VUPTKE 121
 BFSKIN=BFSKNR 122
 BFLEG=BFLEGR 123
 BFARM=BFARMA 124
 BFRSP=BFRSPR 125
 BFCOR=BFCCR 126
 HLGINC=0 127
 WARINC=0 128
 HUMINC=0 129
 TMPINC=0 130
 PATINC=0 131
 PBRINC=0 132
 VELINC=0 133
 HTBR=02BR=004825 134
 HTLEG=02LG=004825 135
 HTARM=02AR=004825 136
 HTSKN=02SK=004825 137
 HTRSP=02RSP=004825 138
 PCRSAD=A MAX1(0,1,IMX RSP+V/VMAX=4.5)) 139
 02XPRE=0 140
 IF (TB.LT.TBSH .OR. TSKIN.LT.29.) GO TO 102 141
 02XRSP=02BR+02OTH+02AR+02LG+02COR+02SK+02IM 142
 DTSW=A MIN1(3,(TB-TBSW)) 143
 HLSW=8.4*(TB-TBSW)*TS 144
 BFSKIN=BFSKNR+BFSKNR*DTSW*7./3. 145
 IF (HLSW>GT.HLSW=HLSWX) HLSW=HLSWX 146
 GO TO 103 147
 102 HLSW=0 148
 DTSW=0 149
 103 CONTINUE 150
 HTTOT=HTBR+HTIM+HTOT+HTCOR+HTLEG+HTARM+HTSKN+HTRSP 151
 NYEXP=10.***((8.*051*(2353./((TB+273.+18.)))*PRESS/101.+3 152
 HLRSP=04*v*85984.*WEXP*WV)**2882/(TAIR*273.)*60.)*TS 153
 HTNET=HTTOT+HLRSP 154
 HLSKIN=17.*1*AB.*TSKIN-TAIR)*TS*0.85984./60. 155
 HTSTOR=HTNET+HLSW+HL SKIN 156
 TIME=0 157
 PRTIME=0 158
 INCTIME=0 159
 TPRNT=1 160
 JPR=6 161
 DO 600 I=1,6 162
 600 IPRIII=1 163
 900 FORMAT (68A1) 164
 C REMOVED INTERACTIVE SECTION 165
 C 166
 4000 CONTINUE 167
 C 168
 C*** C 169
 C*** C 170
 C MODEL EXECUTION 171
 C 172
 C 173
 C 174 175

C***
 C4000 WRITE (3) PVAL
 C NRECS=NRECS+1
 C*** FIRST CHECK TO SEE IF STOP, PRINT, OR OTHER HALT MINTS REACHED
 C IF (ISTART.NE.0) GO TO 4001
 C WRITE (6,114*) (PRNAME(IPR(I)),I=1,JPR)
 1144 FORMAT (1H ,3X,6(4B,4X))
 WRITE(6,601)
 601 FORMAT (TIME V02 V HR CO TB)
 ! TSKN!!
 READ(5,10)TPRNT
 READ(5,27)WK
 27 FORMAT(6(8F10.0/),2FIU*0)
 ISTART=1
 4001 IF (TIME.LT.STOPTM) GO TO 4010
 C WRITE (6,4002)
 C 4002 FORMAT (I STOPTIME EXCEEDED. DO YOU WISH PLOT (Y/N)?)
 C READ (5,9001 A1)
 C IF (A1(1).EQ.'Y') GO TO 4005
 C4003 WRITE (6,*00*)
 C4004 FORMAT (I DO YOU WISH TO RESTART (Y/N)?)
 C READ (5,9001 A1)
 C IF (A1(1).EQ.'Y') GO TO 525
 GO TO 10000
 C
 C4005 REMOVED PLOTTING ROUTINE
 C
 4010 IF (TIME.LT.PRTIM) GO TO 4020
 PRPTIM=TIME+TPRNT
 C ISTART=ISTART+1
 C IF (ISTART.LT.10) GO TO 40105
 C WRITE (6,114*) (PRNAME(IPR(I)),I=1,JPR)
 C ISTART=1
 C0105 WRITE (6,4012) (PRVAL(IPR(I)),I=1,JPR)
 C CHANGED VARIABLE OUTPUT
 *0105 WRITE(6,4012) TIME,02TOT,V,HR,CO,TB,TSKIN
 *0112 FORMAT (1H ,F8.1,6F9.1)
 C*** TEMPORARY CONTINUE OPTION
 C IPT=0
 C CALL TREAD(A,ALFA,FPP,IND,IPT)
 C IF (IND.NE.0) GO TO 1006
 C*** END OF TEMPORARY SECTION
 C
 C REMOVED VARIABLE INCREMENTING SECTION
 C
 4020 T=TIME+60.0
 IF IT*KLISTART(1)=26,25,25
 25 02LEG=KLISTART+1**+485/*+23+02LEGR
 ISTART=ISTART+2
 26 CONTINUE
 C*** START EXECUTION LOOP
 C*** RESPIRATION RATE
 4050 V=02TM/T8/VUPTKE
 C WRITE (6,111) V
 111 FORMAT (I : V:,F10.1)
 C*** BRAIN
 02BR=02BRR+TS
 HTBR = 02BR * 004825
 C*** INACTIVE MUSCLE

021M = 021MRTS
 HTIM = 021M * 004825
 C*** OTHER COMPARTMENT
 HTOTH = 026TH * 004825
 C*** CORONARY COMPARTMENT
 IF (HRLT.HRST) HRHRST
 02C0R = 11HR(HRST)*MXCR + 02C0RR * TS
 BFC0R = BFC0RR + 102C0R/TS*02C0RR)/AVC0R
 HTC0R = 02C0R * 004825
 IF (02C0R/TS).LT.92CHMX) GO TO 4060
 DBC0 = DBC0 + (02C0R/TS*02CHMX)*004825
 BFC0R = BFC0MX
 IF (DHC0.LT.0B0CMX) GO TO 4060
 WRITE (6,4055) DBC0
 *055 FORMAT (1,0)DEBT (CHRONARY) EXCEEDS MAX. DEBT = 1,F8.1)
 GO TO 10000
 C*** LEG MUSCLE COMPARTMENT * *
 4060 B2LG = B2LEG * TS
 BFLG = BFLGR+ (02LG-B2LEG)/AVM0MX
 IF (BFLEG.LT.BFLGMX) GO TO 4068
 BFLEG=BFLGMX
 DT0BLG = (02LEG-B2LGMX)*004825
 IF (DT0BLG.LT.DTLGMX) GO TO 4065
 WRITE (6,4062) DT0BLG
 *062 FORMAT (1 RATE OF LEG MUSCLE 02 DEBT ACCUM EXCESSIVE (1,F8.3
 **,11)
 GO TO 10000
 4065 DBLEG = DBLEG+DTDBLG*TS
 IF (DBLEG.LT.DBLGMX) GO TO 4068
 WRITE (6,4067) DBLEG
 *067 FORMAT (1 LEG MUSCLE 02 DEBT EXCESSIVE (1,F8.1,1))
 GO TO 10000
 4068 HTLEG = 02LEG*TS*004825
 IF (02LEG.LE.02LEGR) GO TO 4075
 IF (02LEG.GT.(EFLGMX*02LGMX)) GO TO 4070
 HTLEG = HTLEG + (02LEG-02LEGR)*75*004825 * TS
 GO TO 4075
 4070 HTLEG=HTLEG+((EFLGMX*02LGMX*02LEGR)*0.75+(02LEG-EFLGMX
 * 02LGMX)*0.90)*0.004825*TS
 C*** ARM MUSCLE
 4075 02AR = 02ARM * TS
 BFArm = BFArm + 102AR * 02ARM/AVM0MX
 IF (BFArm.LT.BFARMX) GO TO 4082
 BFARM = BFARMX
 DTDBAR = 102ARM*02ARM)*CO4825
 IF (DTDBAR.LT.DTDBAR) GO TO 4080
 WRITE (6,4087) DTDBAR
 *078 FORMAT (1 RATE OF ARM 02 DEBT ACCUM EXCESSIVE (1,F8.1,1))
 GO TO 10000
 4080 DBARM = DBARM + DTDBAR * TS
 IF (DBARM.LT.DBARM) GO TO 4082
 WRITE (6,4081) DBARM
 *081 FORMAT (1 ARM MUSCLE 02 DEBT EXCESSIVE (1,F8.1,1))
 GO TO 10000
 4082 HTARM = 02ARM*004825*TS
 IF (02ARM.LE.P2ARM) GO TO 4090
 IF (02ARM.G1*(EFARM*02ARM)) GO TO 4085
 HTARM = HTARM+(02ARM-02ARM)*004825*TS*.75
 291
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GO TO 4090
 * 4085 HTARM=HTARM+11EARMX*024RMX*02ARMR)*0.75+(H2ARM-EFARM
 * * * * *
 C**** SKIN OXYGEN CONSUMPTION
 * 4090 HTSKIN=32SKN*004825
 C**** RESPIRATORY COMPARTMENT
 CALCULATE TOTAL NON-RESP 02 CONSUMPTION
 02XRSP = 0102BR+02C0R+02AR+02LG+02SK+321M+02OTH
 IF 102XRSP>EQ.02XRSP1 GO TO 4100
 PCRSAD = MXRSP*V/VMAX=4.5
 IF 1PCRSAD .LE.0.1 PCRSAD = 0.
 PCRSPT = PCRSAD + PCTRSP * 0.01
 02TOT = 02XRSP / (1+PCRSPT)
 02RSP = 02TOT*PCRSPT
 IF 102RSP/TS.LT.02RSPT1 02RSP=02RSPP*TS
 HTRSP = 02RSP*.004825
 BFRSP = BFRSPR+102RSP/TS=02RSPR/AVFSMX
 02XPREF=02XRSP
 *100 V = 02TOT/TS/VUPTKE
 C*** WRITE (6,10) 02LEG,02ARM,02COR,02RSP,02TOT
 IF (V.LT.VMAX) GO TO 4110
 WRITE (6,4102) V
 *102 FORMAT (1V EXCEEDS MAXIMUM ALLOWABLE VENTILATION, RATE NOW'F8.1)
 GO TO 10000
 C*** SUM TOTAL BLOOD FLOW * * *
 *110 CD = BFLLEG+BFBARM+BFCOR+BFIMR+BFOTH+BFBR+BFRR+BFSP
 C*** WRITE (6,9) CD,BFLLEG,BFBARM,BFCOR,BFSKIN,BFIMR,BFOTH,BFBR
 C*** 9 FORMAT (1CD,BFLLEG,BFBARM,BFCOR,BFSKIN,BFIMR,BFOTH,BR=1,/, '9F7.1)
 C*** 10 FORMAT (102(LEG,ARM,COR,SKIN,RESP,IM,OTH,BS=1,/, '1,5F10.4);
 HRACB/SV
 IF (HR.LT.HRMAX) GO TO 4120
 WRITE (6,4112) HR
 *112 FORMAT (1HEART RATE 'F8.1,1EXCEEDS MAXIMUM')
 GO TO 10000
 C***
 C*** HEAT BALANCE PORTION OF MODEL
 *120 CONTINUE
 HTTOT = HTBR + HTLEG+HTARM+HTCOR+HTSKIN+HTRSP+HTIG+HTOTH
 C*** WRITE (6,14) HTTOT,HTBR,HTLEG,HTARM,HTCOR,HTSKIN,HTRSP,HTOTH
 C*** 14 FORMAT (1HT PROD10T,BR,LEG,ARM,COR,SKIN,RESP,IM,OTH,/
 C*** 1,1,5F10.5,1,4F10.5)
 C*** CALCULATE VAPOR PRESSURE AT BODY TEMP
 WVEXP = 10** (8*4051 *(2353/(TB+273.18)))*PRESS/101.3
 HLRSP=.04*V*85984*(WEXP-WV)*2882/((TAIR+273.1*60.1)*TS
 HTNET=HTTOT*HLRSP
 C*** HEAT LOSS FROM SKIN BLOOD FLOW * * *
 HLSKIN = 17.1*AB*(TSKIN-EFSKIN)
 C*** WRITE (6,93) TSKIN,EFSKIN
 C*** 93 FORMAT ('TSKIN',BFSKIN)', '2F8.1)
 C*** NOTE. OTHER WAYS TO CALCULATE SKINT. IS THIS BEST ***
 C*** WVSIN = (10** (8*4051 *(2353/(TB+273.18)))*PRESS/101.3
 C*** CALCULATE HEAT LOSS THROUGH SWEATING* * *
 IF (TB.LT.TBSW) GO TO 4150
 IF (TSKIN.LT.29.0) GO TO 4150
 HLBW = 8*4 *(TB-TBSW)*TS
 HLSWMX=11.79*(VAIR**0.37)*(VSKIN-V)*AB/60.*0.8584 *TS
 DTBSW=TBSW
 IF (DTSW.GT.3.) DTSW=3.

PRINTED IN U.S.A.

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C IF (A(1).EQ.KYES) GO TO 520
      411
      35AP
END      412
      413

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SCALAR MAP

INCTIM	0114(T)	MXCUR	0043(T)	MLEG	0058(T)	MARY	0050(T)	MRESP	005F(T)	MCHR	0061(T)
MIM	0063(T)	MXRSP	0032(T)	FIRST	0038(T)	SNSW	0039(T)	NCNTL	0004(P)	NHATS	0000(P)
NOUT	000C(P)	MIN	000D(P)	KYES	002E(P)	KNP	002F(P)	KEND	J030(P)	AVER	0010(T)
AVBR	0012(T)	AVMR	0014(T)	AVSKIN	0015(T)	AVTHR	0018(T)	AVRSPR	001A(T)	AVMMX	001C(T)
AVRSMX	001E(T)	EARMX	0020(T)	EFLGMAX	0021(T)	PCTWLG	0024(T)	PCTMAR	0026(T)	PCTMRS	0028(T)
PCTWCO	002A(T)	PCTWIM	002C(T)	STOPTM	002F(T)	TINC	0030(T)	TS	0034(T)	VPTKE	0036(T)
ISTART	003A(T)	TAIR	003B(T)	RHUM	003D(T)	PRESS	003F(T)	P02	0041(T)	V4R	0043(T)
CORST	0045(T)	WGT	0047(T)	HGT	0049(T)	T8	0048(T)	MRRST	2040(T)	MMAX	004F(T)
VMAX	0051(T)	TRMAX	0053(T)	WAWS	0055(T)	AV	0057(T)	AB	0059(T)	SY	0065(T)
G2LGMAX	0067(T)	G2ARMX	0069(T)	G2COMX	006B(T)	G8LGMX	006D(T)	DBARMX	0071(T)	D8CMX	0071(T)
DTLGMAX	0073(T)	DTARMX	0075(T)	BFBRX	0077(T)	BFRSGR	0079(T)	BFARMR	007B(T)	BFCMR	007D(T)
GFSKNR	007F(T)	BF8THR	0081(T)	G2BRR	0083(T)	C8	0085(T)	B2LEGR	0087(T)	DCARMR	0089(T)
G2C0RR	008B(T)	G2SKNR	008D(T)	G2OTHXR	008F(T)	G2T3	0091(T)	PCTRSP	0093(T)	G2RSPR	0095(T)
G2IMQ	0097(T)	BFRSPR	0099(T)	BFIMR	009B(T)	BFLGMR	009D(T)	BFARMX	009F(T)	BFCDMX	00A1(T)
HLSWMX	00A5(T)	WVSKN	00A7(T)	TSKIN	00A9(T)	TMSW	00AB(T)	G2IM	00AD(T)	HR	00AF(T)
G2BTH	00B1(T)	G2BLT	00B3(T)	G2LEG	00B5(T)	G2LG	00B7(T)	G2ARH	00B9(T)	G2AR	00B9(T)
G2C0R	00BD(T)	G2RSP	00BF(T)	G2SK	00C1(T)	G2TET	00C3(T)	DBCB	00C5(T)	DBLEG	00C7(T)
DBARM	00C9(T)	DTDBLR	00CB(T)	DTDBLG	00CD(T)	V	00CF(T)	BFSKIN	J0D1(T)	BFLEG	00D3(T)
BFARM	00D5(T)	BFRSP	00D7(T)	BFCUR	00D9(T)	MLGINC	00DB(T)	WARIINC	00DD(T)	HUMINC	00DF(T)
TMPIINC	00E1(T)	PATINC	00E3(T)	PBZINC	00E5(T)	VELINC	00E7(T)	HTBR	00E9(T)	HTLEG	00EB(T)
HTARM	00ED(T)	HTSKN	00EF(T)	HTRSP	0CF1(T)	PCRSAD	00F3(T)	G2XPRE	00F5(T)	M2RSP	00F8(T)
HTSW	00FA(T)	HLRW	00FC(T)	HTTOT	00FE(T)	HTIM	0020(T)	HTOTM	0102(T)	HTCBR	0104(T)
HWEXP	0106(T)	HLRSP	0108(T)	HTNET	010A(T)	HLSSKIN	010C(T)	HISTRB	010E(T)	TIME	0110(T)
PRTTIM	0112(T)	TPRNT	0116(T)	JPR	0118(T)	I	0119(T)	T	011A(T)	PCRSPT	011D(T)

ARRAY MAP

X	0125(T)	Y	0189(T)	A	01ED(T)	IPR	0231(T)	CNTL	020E(P)	TOTAL	0237(T)
PRVAL	0331(T)	NAME	0395(T)	MUT	048F(T)	IM	04E9(T)	IN	04E9(T)	CAN	0502(T)
OUTNAM	0031(P)	PRNAM	0589(T)	LENAME	008B(P)	INRAME	0095(P)	CONNAM	00A1(P)	HK	05E0(T)

EXTERNAL PROCEDURES

:!AMAX1	::AMIN1	M:RES	L:88S	L:88C	L:33L3	L:33A1	L:33R3	L:33L!			
L:33D3	L:33S1	L:3N	L:33E3	L:33D1	L:93A3	L:33M3	L:33E1	L:33M1			
L:33S3	L:33T3	L:33T1	L:32R3	L:88S2	L:88C2	L:33S2	L:33L2	L:32E3			
L:88X											

LABEL MAP

:!110	0163	:!525	0167	:400	0335	:410	0343	:420	034E	:95	03A1	:102	0490
:!1103	0498	:600	052C	:900	053F	:4000	0542	:4001	05AB	:1144	054B	:601	0561
:!1127	059F	:4C10	05B4	:10000	0B4A	:4020	05E9	:40105	05C3	:4012	05E1	:26	0612
:!1125	05FD	:4050	0612	:11	0625	:4060	06C0	:6047	:4068	:749	:4065	:0714	
:!11062	06F6	:4067	0732	:4075	0791	:4070	0773	:4082	081B	:4080	07E8	:4078	07CD
:!11081	08C4	:4090	0863	:4085	0843	:4100	08D8	:4110	091D	:4102	08FF	:4120	095E
:!1112	0948	:4150	0A86	:4158	OAC1	:4160	0AF5	:4148	0A64	:4161	0A45	:4159	0A02
:!11170	0842	:4162	0B24	:10002	0B64	:10004	0BE6	:10006	0C4A				

TEMP ORIGIN OCFB LENGTH 0651
PROGRAM LENGTH 134C
0 ERRORS